



NAVAL  
POSTGRADUATE  
SCHOOL

# Software Engineering Program

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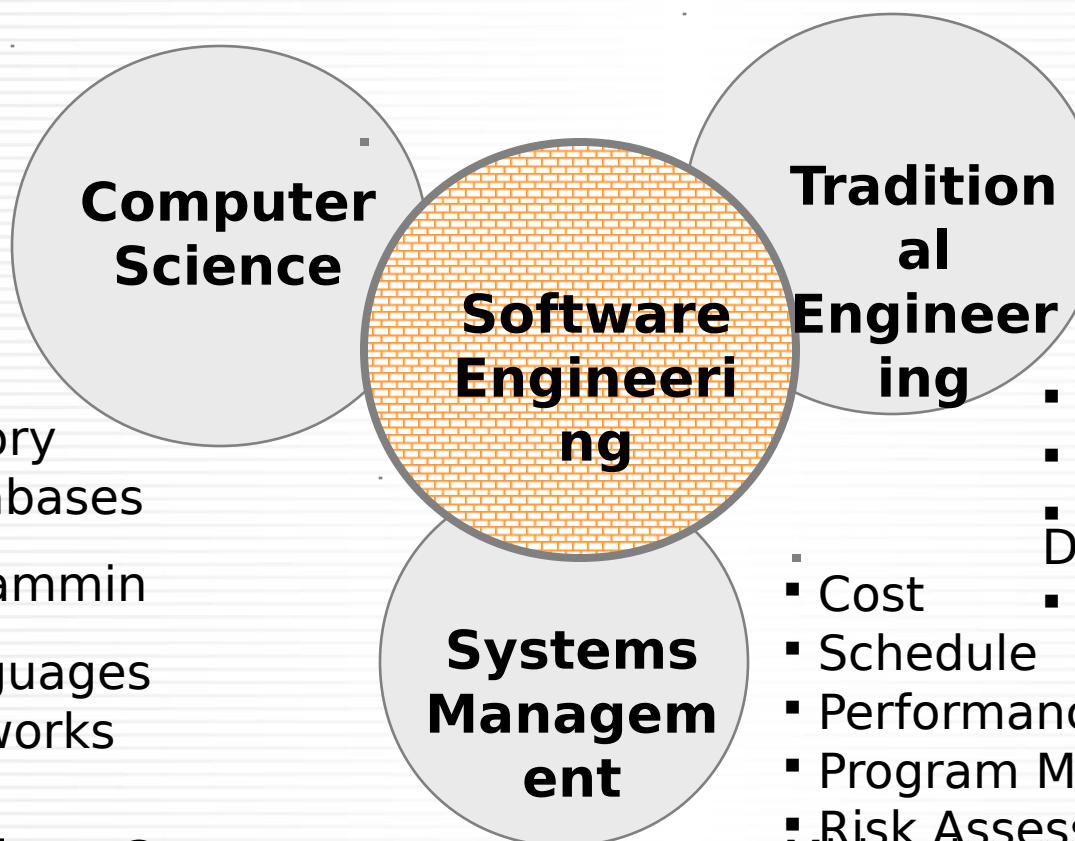
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# What is Software Engineering?

## Software Engineering Program

Engineering real-world software products and systems on schedule, within budget, and with the desired functionality and level of dependability (i.e., sum of the “ilities”)



# Why should the DoN invest in Software Engineering Education?

## Software Engineering Program

- Modern defense systems are software-intensive systems-of-systems
  - Majority of the functionality of these systems resides in software
    - Warfighter is being placed on the fringes to handle exceptions, with the rest of the system being highly automated
      - These systems need to be highly dependable
  - Realization of desirable emergent capabilities and behaviors of these systems is dependent on Software Systems Engineers
    - It takes engineers and other acquisition professionals with expertise in software engineering to do this ("the Devil is in the detail")
- Too few government personnel—civilian and military—with deep knowledge and honed problem-solving skills in Software Engineering
  - Software system acquisition in DoD is infamous for program cost and schedule overruns, poor system quality, missing capabilities, etc.



## Software Engineering Program

The NPS Software Engineering Program offers graduate education in the principles and practices of software engineering with thesis options of military relevance and significance

We combine a systems perspective with modeling and design at all levels of levels of representation from capabilities and requirements down to executable code



# Program Objectives

## Software Engineering Program

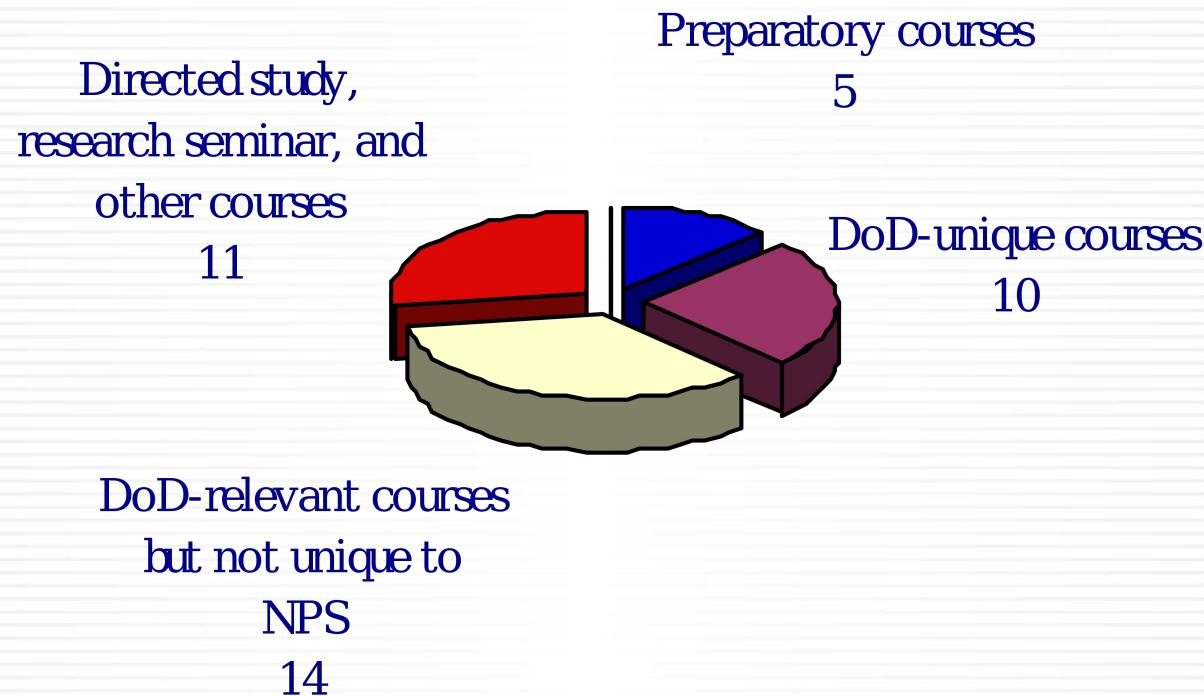
Provide military and civilian graduate students with study in all the relevant levels of software development

Provide the skills needed to plan, design, and implement large-scale software-intensive systems using the best available science and technology

*These skills are essential for officers and civilians responsible for acquisition, development or maintenance of defense software*

## Software Engineering Program

There are 40 courses within the Software Engineering curriculum, the majority of which are either DoD-unique or DoD-relevant





## Software Engineering Program

- These are courses that cover DoD subject matter and are not offered at other universities
  - **MN3309**, *Acquisition of Embedded Weapon Systems Software*
  - **SW4530**, *Software Engineering R&D in DOD*
  - **SW4555**, *Engineering Network Centric Systems*
  - **SW4560**, *Software Evolution*
  - **SW4582**, *Weapon System Software Safety*
  - **SW4592**, *Software Risk Assessment in DOD*
  - **SW4593**, *Advanced Logic & Algebra for Software R&D in DOD*
  - **SW4597**, *Robust Generation of Control Software*
  - **SW4599**, *Automated Software/Hardware Integration in DOD*
  - **SW4600**, *Automata, Formal Specification and Run-time Verification*



## Software Engineering Program

- These are courses that place a heavy emphasis on DOD subject matter, but the course topics themselves are not unique to NPS
  - **SI4011**, *System Engineering for Acquisition Managers*
  - **IS4300**, *Software Engineering and Management*
  - **MN3331**, *Principles of Systems Acquisition and Program Management*
  - **SW4500**, *Introduction to Formal Methods in Software Engineering*
  - **SW4510**, *Computer-Aided Prototyping*
  - **SW4520**, *Advanced Software Engineering*
  - **SW4540**, *Software Testing*
  - **SW4570**, *Software Reuse*
  - **SW4580**, *Design of Embedded Real-Time Systems*
  - **SW4581**, *Software Reliability*
  - **SW4583**, *Principles of Software Design*
  - **SW4590**, *Software Architecture*
  - **SW4591**, *Requirements Engineering*
  - **SW4598**, *Software Merging and Slicing Techniques*



# Preparatory Courses

## Software Engineering Program

- These are courses that students without a Software Engineering background or who do not have an engineering degree may need to complete before entering the master's degree or certificate programs
  - **IS3301**, *Fundamentals of Decision Support Systems*
  - **SW2920**, *Introductory Topics in Software Engineering*
  - **SW3460**, *Software Methodology*
  - **SW3800**, *Directed Study in Software Engineering*
  - **SW3920**, *Topics in Software Engineering*



# MS Software Engineering (MSSWE)

## Software Engineering Program

- The MSSWE degree was established at NPS in 1995
- All recipients of the MSSWE degree must
  - Become competent in Software Engineering core subjects
  - Develop advanced expertise in one or more of the following functional areas of Software Engineering:
    - Software Requirements Engineering
    - Software Design
    - Software Construction
    - Software Testing
    - Software Evolution & Maintenance
    - Software Quality Engineering
    - Software Engineering Management
    - Software Engineering Infrastructure
    - Software Engineering Process



# MS Computer Science (MSCS) Software Engineering &

## Software Engineering Program

- The department also offers the MSCS Software Engineering & Architecture track, consisting of four areas of study:
  - Weapon System Software Safety
    - Software Testing
    - Weapon System Software Safety
    - Advanced Topics in System Safety and Reliability
  - Software Maintenance and Evolution
    - Computer Aided Prototyping
    - Software Evolution
    - Software Reuse
  - Software Testing and Quality Assurance Management
    - Software Testing
    - Software Reliability
    - Computer Aided Prototyping
  - Real-time System Design
    - Design of Embedded Real-time Systems
    - Computer Aided Prototyping
    - Automata, Formal Specification and Run-time Verification



# PhD Program in Software Engineering

## Software Engineering Program

- First doctoral program in Software Engineering in the world (established in 1998)
- Provides a unique program of study supporting the advancement of Software Engineering principles and technology to DoD researchers and practitioners, enabling them to
  - Acquire skills and knowledge needed to perform state-of-the-art research on issues related to the development of large complex software systems
  - Direct and manage teams of software professionals



## Software Engineering Program

- Core subjects integrate fundamental principles:
  - Software methodology
  - Software engineering and management
  - Introduction to formal methods in software engineering
  - Principles of software design
  - Software risk assessment
- And provide problem-solving skills in areas such as:
  - Conducting capabilities-based acquisition of systems-of-systems
  - Designing mission- and safety-critical systems to be highly dependable
  - Developing open architectures
  - Using service-level agreements to procure software systems
  - Planning and managing outsourcing

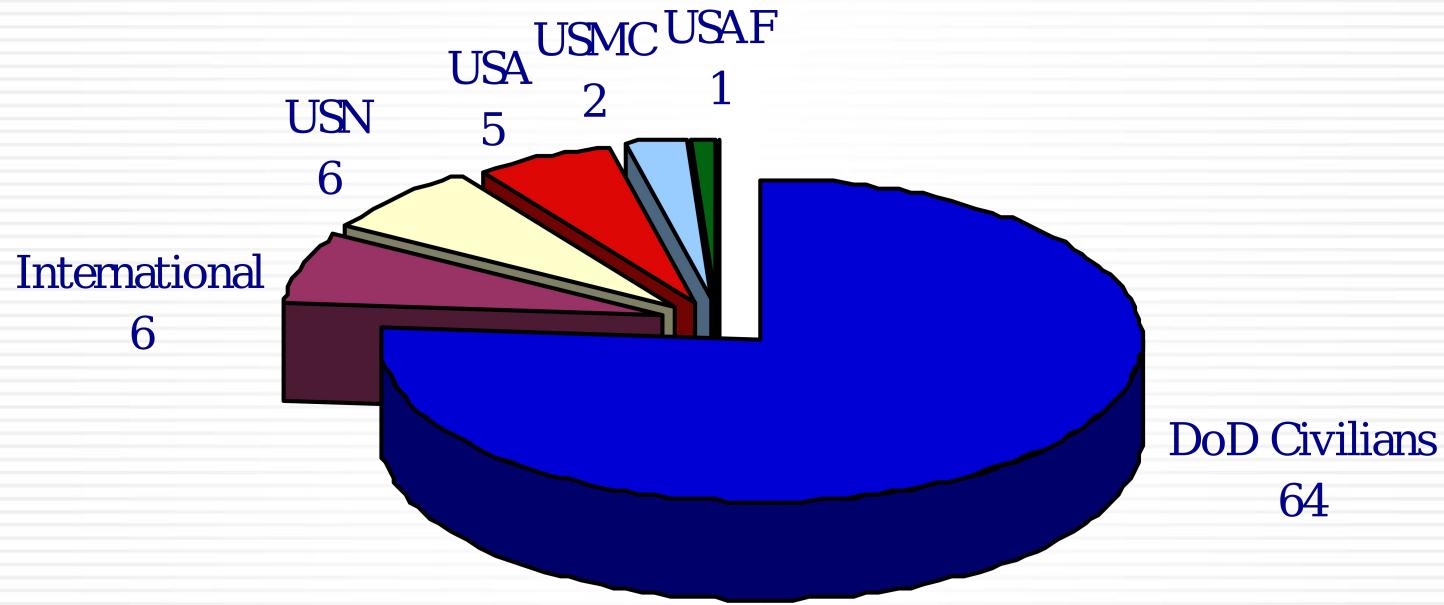


## Software Engineering Program

- The Software Engineering MS and PhD curricula are
  - Fully accredited
  - Homed in the Department of Computer Science
    - 45 CS faculty, including
      - 22 tenure-track (TT) professors
      - 4 military faculty (MILFAC)
    - Faculty affiliated with the
      - Department of Information Sciences
      - Graduate School of Business & Public Policy
      - Department of Systems Engineering
        - » The faculty in these two groups provide expertise in Software Acquisition, Software Management, Software Economics, and Systems Engineering

# MSSWE Graduates (since 1995)

## Software Engineering Program

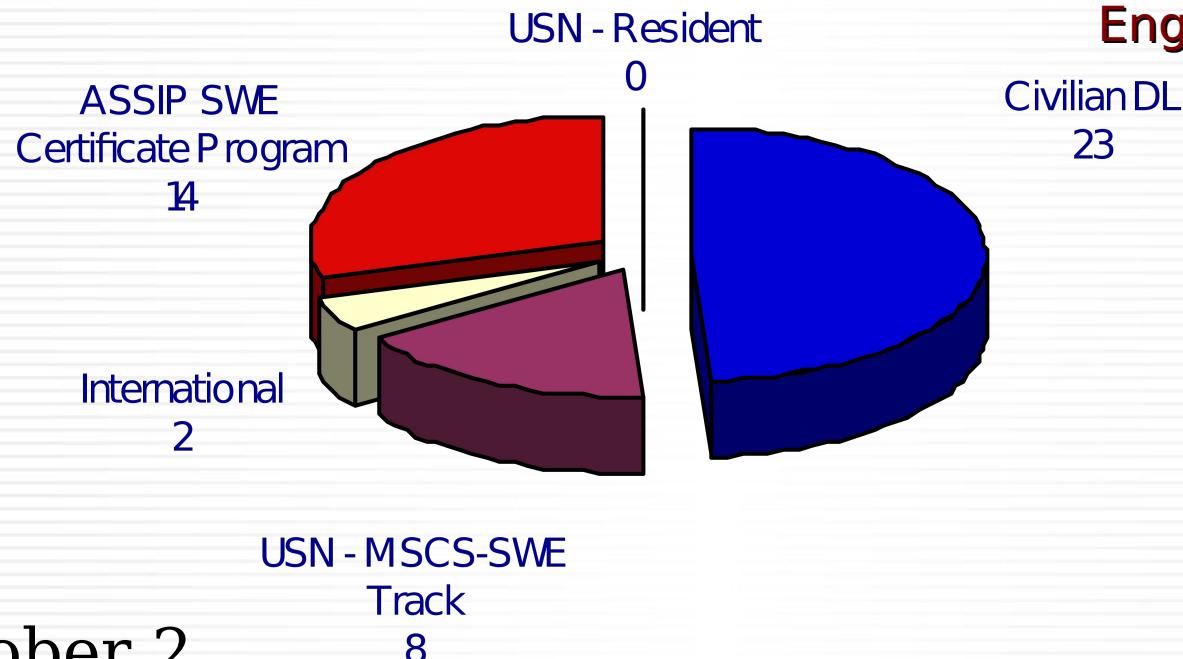


# Current MSSWE Student Body

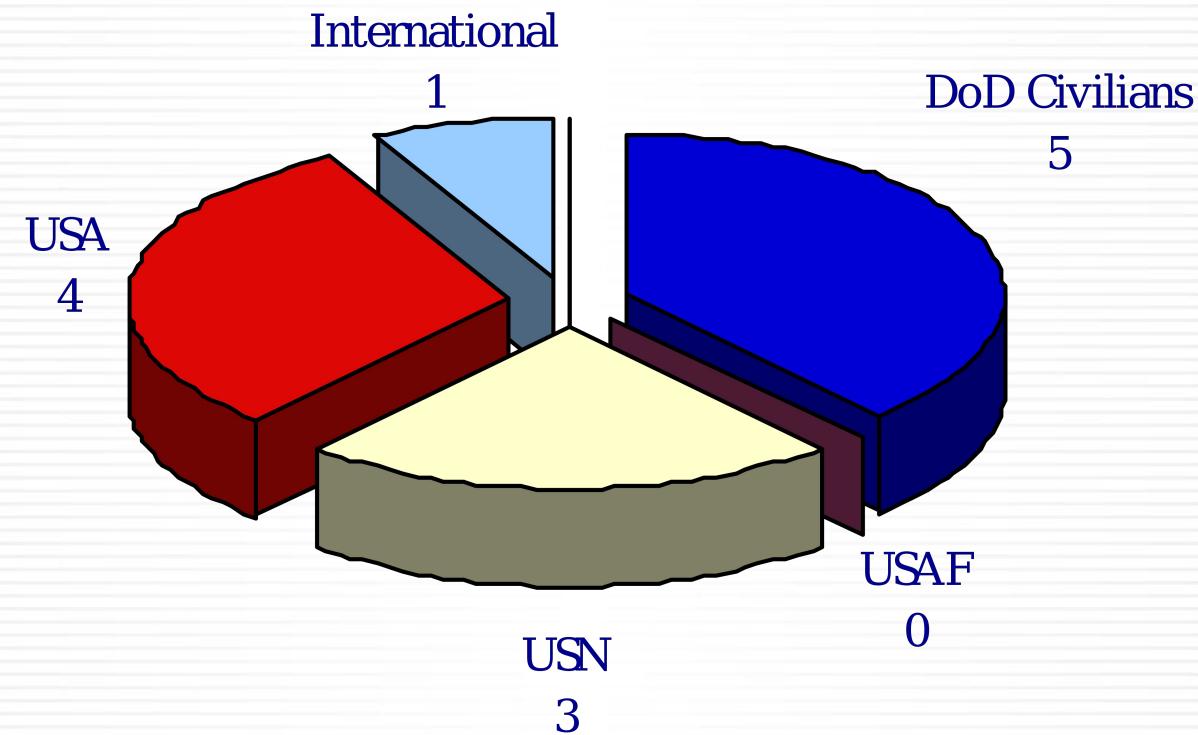
## Software Engineering Program

Navy EDOs and SWOs study Software Engineering at NPS in the Software Engineering track of the M.S. in Computer Science (MSCS-SWE) degree program

The USN does not send students to NPS to obtain a MS SWE degree—there is no P-Code for Software Engineering!



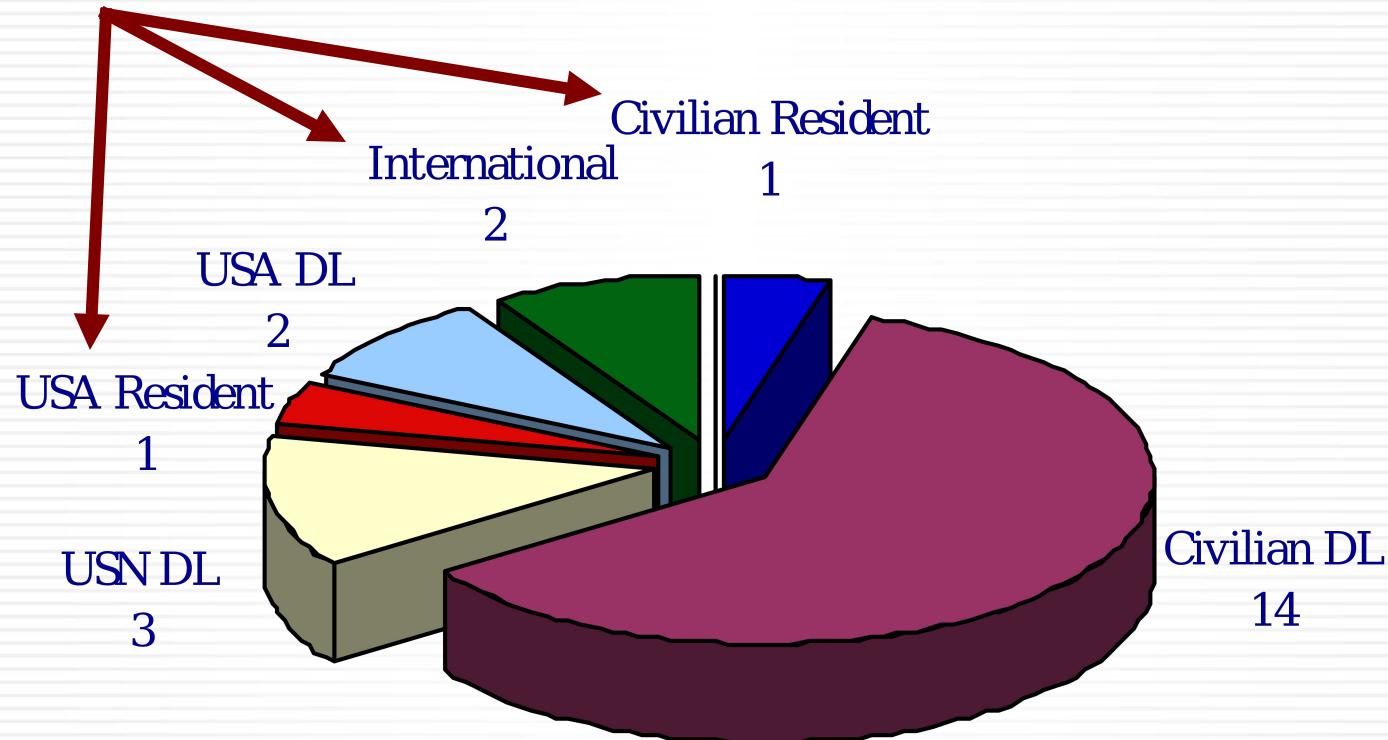
## Software Engineering Program



# Current PHDSWE Student Body

## Software Engineering Program

One full-time student each





## Software Engineering Program

### **Committed to providing outreach with the help of Distance Learning technology...**

- In addition to resident education, we deliver the same MS and PhD programs in Software Engineering via DL
- 26 faculty including most of the TT have completed IDL (Interactive Distributed Learning) course
  - Using Blackboard to host their course Web sites
- Organizations that fund students to study Software Engineering via DL include SPAWAR, NAVSEA, NSWC, NSA, MDA, Army TACOM, and Asst. Sec. of Army (ALT)
- We also conduct
  - Certificate programs
  - Short courses



# Army Strategic Software Improvement Program (ASSIP)

## Software Engineering Program

- In 2004, NPS established a certificate program in Software Engineering for the Army Strategic Software Improvement Program (ASSIP)
  - Sponsored by the Office of the Assistant Secretary of the Army, Acquisition, Logistics, and Technology
  - The students are DoD civilians who serve in key software acquisition roles
  - We tailor each certificate course of study to the sponsor's needs
    - Each certificate course of study consists of a sequence of four courses
    - Current cohort (Academic Year 2006) of students are enrolled in the Weapon System Software Safety certificate program of study
  - Students can apply three certificates (i.e., twelve courses) toward completing the requirements for the MSSWE—the other requirement is to complete an acceptable thesis



# Examples of Recent Doctoral Dissertations

## Software Engineering Program

- Developing Dependable Software for a System-of-Systems
  - Dr. Butch Caffall, HQ Missile Defense Agency
- Evolving a Simulation Module Product Line Software Architecture from heterogeneous Model Representations
  - Dr. Kevin Greaney (COL, USA Ret.)
- Improving Software Quality and Management through the Use of SLAs
  - CDR Leonard Gaines, USN, HQ Defense Logistics Agency
- A Formal Application of Safety and Risk Assessment in Software Projects
  - CDR Christopher Williamson, USN

# Examples of Recent Master's Theses

## Software Engineering Program

- A Test Methodology for Reliability Assessment of Collaborative Tools
  - Ms. Brenda Powers, SPAWAR
- Convergence of the Naval Information Infrastructure
  - LCDR James Knoll, USN
- A Methodology for Developing Timing Constraints for the Ballistic Missile Defense System
  - CDR Michael Miklaski, USN and CPT Joel Babbitt, USA
- Extending the Computer-aided Software Evolution System (CASES) with Quality Function Deployment (QFD)
  - MAJ Arthur Clomera, USA

## Software Engineering Program

### The Department of Computer Science's New State-of-the-Art Facilities



- Modeled after Stanford University's Center for Innovations in Learning
- Represents over \$12 million in new MILCON construction
  - Scheduled for completion in 2006
- Over 32,000 sq. ft. of new space
  - 12,000 of it dedicated to DoD-funded research
  - 11 new labs utilized for research in Software Engineering and Computer Science
- Will include the latest in technology for
  - VTE (Video Tele-Education) and Smart-classroom



# Supporting NPS Value Propositions

## Software Engineering Program

- Civilians obtain the problem-solving skills and knowledge they need to engineer and manage DoD software-intensive systems
- Military officers receive a first-class education while immersed in military values and culture, significantly enhancing retention
  - Approximately 25% of flag officers have NPS degrees
- Approximately 90% of SWE students enter the Software Engineering program with experience in leading or managing a defense software development or maintenance program
- Many of our MS theses and PhD dissertations save external sponsors millions in consulting fees by providing studies -- NPS is a think tank



## Software Engineering Program

- We propose that the Navy Software Process Improvement Working Group
  - Take ownership of NPS' Software Engineering Program in order to champion one or both of the following:
    - Finding a Navy sponsor for the program
    - Agreeing on Engineering Skill Requirements (ESRs) for military officers and securing a P-Code (postgraduate education designator) for Software Engineering
      - This is needed in order to create billets and quotas for the Navy to send its officers to NPS to study Software Engineering
  - Take a leadership role in increasing the enrollment of members of the DoD civilian workforce in the resident and distance learning offerings of the Software Engineering program
    - The Naval Education and Training Command (NETC) will most likely not continue to subsidize NPS' DL programs when the Navy-wide 10% cut in funding takes effect this fiscal year
    - The curriculum is already in place, but is at present underutilized by the DoN and DoD



# Discussion...

Future role of NPS' Software Engineering resident and distance learning programs in supporting Navy and DoD objectives, including software process improvement initiatives